

VERIFICATION OF TRANSLATION

I, Timothy S. Price, translator at Nakajima & Matsumura Patent Attorneys Office, 6F Yodogawa 5-Bankan, 3-2-1 Toyosaki, Kita-ku, Osaka, 531-0072, Japan, hereby declare that I am conversant with the English and Japanese languages and am a competent translator thereof. I further declare that to the best of my knowledge and belief the following is a true and correct translation made by me of Japanese Patent Application Publication No. H07-192630 filed on December 27, 1993.

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15 (54) [TITLE OF THE INVENTION] GAS DISCHARGE DISPLAY PANEL AND
PROTECTIVE FILM FORMING METHOD THEREFOR

(57) [ABSTRACT]

[PURPOSE] To provide a protective film suited for mass
production and further having more favorable panel characteristics,

20 in an AC-type PDP.

[STRUCTURE] An electrode 10, a wall charge accumulating dielectric 14 and a protective film 16 are sequentially provided on a soda lime glass substrate 18. The protective film 16 is a sintered body composed of MgO particles 16a, 16b of different
25 particle diameters and an MgO binder 16c. A precursor in liquid phase serving as MgO by baking is used to form the binder 16c. Thus, mass production of the protective film 16 is facilitated.

It is difficult to increase the crystal grain density of the binder 16c if the precursor is baked at 580°C or less so the soda lime glass does not degenerate. However, since the particles 16a and 16b have different particle diameters, the distribution density 5 of these particles in the protective film 16 can be increased. Accordingly, the crystal grain density of the protective film 16 can be increased by forming these particles as monocrystal grains.

10 [CLAIMS]

[CLAIM 1] A gas discharge display panel that is AC-type, comprising:

a first electrode and a second electrode for forming gas discharges for display;

15 a wall charge accumulating dielectric that covers the first and second electrodes; and

a protective layer provided on the wall charge accumulating dielectric, wherein

the protective layer is a sintered body including (i) 20 particles, a portion of which have a large particle diameter, and another portion of which have a small particle diameter, and (ii) a binder for binding the particles.

[CLAIM 2] The gas discharge display panel of claim 1, 25 wherein

a constituent element of the binder is a same type as a constituent element of the particles.

[CLAIM 3] The gas discharge display panel of claim 1,
wherein

the particles are monocrystal grains.

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[CLAIM 4] The gas discharge display panel of claim 1,
wherein

the particles are MgO particles, and
the binder is an MgO binder.

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[CLAIM 5] A protective film formation method for a gas discharge display panel, for forming a protective film on a wall charge accumulating dielectric that covers an electrode of an AC-type gas discharge display panel, the protective film formation 15 method comprising the steps of:

providing a paste including (i) particles, a portion of which have a large particle diameter, and another portion of which have a small diameter, and (ii) a liquid-phase precursor that forms a solid-phase binder when baked; and

20 forming the protective layer by laminating the paste on the wall charge accumulating dielectric, and baking the paste.

[CLAIM 6] The protective film formation method for the gas discharge display panel of claim 5, wherein

25 a constituent element of the solid-phase binder is a same type as a constituent element of the particles.

[CLAIM 7] The protective film formation method for the gas discharge display panel of claim 5, wherein the particles are monocrystal grains.

5 [CLAIM 8] The protective film formation method for the gas discharge display panel of claim 5, wherein the paste includes MgO particles and a liquid-phase precursor that forms an MgO solid-phase binder when baked.

10 [CLAIM 9] The protective film formation method for the gas discharge display panel of claim 8, wherein the liquid-phase precursor includes one or more selected from the group consisting of magnesium di-ethoxide, naphthenic-acid magnesium, octylic acid magnesium, magnesium 15 dimethoxide, magnesium di-n-propoxide, magnesium di-i-propoxide, and magnesium di-n-butoxide.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

20 [FIELD OF THE INVENTION]

The present invention relates to a discharge display panel, and in particular to an AC gas discharge display panel and a formation method for a protective film therefor.

[0002]

25 [DESCRIPTION OF RELATED ART]

In recent years, attention has been focused on gas discharge display panels that can have thinner panels and form

display screen with a large surface area. Gas discharge display panels are largely divided into direct-type and AC-type according to the driving method thereof. One example of an AC-type is the surface discharge-type gas discharge display panel disclosed in 5 patent document 1 (The Institute of Television Engineers of Japan Technical Report IDY93-2, January, 1993).

[0003]

In the gas discharge display panel of patent document 1, a plurality of pairs of sustain electrodes are disposed parallel 10 on a substrate, and a wall charge accumulating dielectric and a protective film are sequentially formed on the sustain electrodes. A plurality of address electrodes are disposed parallel on another substrate, barrier ribs are provided between the address electrodes, and phosphor layers are provided on the address 15 electrodes. The two substrates are adhered together such that electrode formation faces thereof are facing each other, and a discharge gas is enclosed between the adhered substrates. The protective film protects the wall charge accumulating dielectric from damage from gas discharges, and thereby functions to lengthen 20 the life of the panel. The protective film is formed from an MgO film that is suitable for not just lengthening the life of the panel, but also reducing the discharge initializing voltage.

[0004]

In such a conventional panel, the MgO protective film 25 is formed by a thin film formation technique, thereby requiring a vacuum container for formation of the thin film. The thin film formation technique enables the formation of an MgO protective

film with a high crystal grain density as well as having even crystallization in the film thickness direction.

[0005]

[PROBLEMS SOLVED BY THE INVENTION]

5 However, increasing the size of the display screen of a gas discharge display panel requires a larger substrate and a large vacuum container for storing the substrate. For this reason, the cost of vacuum devices has become relatively expensive.

[0006]

10 There is a method of forming an MgO sintered body protective film by preparing a paste composed of MgO powder and a liquid-phase precursor that forms an MgO solid binder when baked, and baking this paste. Such a protective film has the advantages of not requiring a vacuum container during formation and being suited 15 for mass production of gas discharge display panels. When forming the protective film from an MgO sintered body, it is important to increase the crystal grain density thereof in order to improve panel characteristics such as the panel life and reduced discharge sustaining voltage.

20 [0007]

 Note that soda lime glass is generally used as the substrate of gas discharge display panels, and accordingly, it is necessary to keep the baking temperature for the paste at or below 580°C to avoid deformation and degradation of the substrate. However, 25 baking the material suited for the liquid-phase precursor at 580°C is too low of a temperature, thereby making it currently difficult to form an MgO binder with a sufficiently high crystal grain density.

In contrast, it is relatively easy to form particles with a high crystal grain density, and in particular, monocrystal grains.

[0008]

The present invention has been achieved in view of these 5 points, and aims to provide a gas discharge display panel that is suited for mass production and can obtain more favorable panel properties, and a protective film formation method therefor.

[0009]

[MEANS TO SOLVE THE PROBLEMS]

10 In order to achieve the above aim, the present invention is a gas discharge display panel that is AC-type, including: a first electrode and a second electrode for forming gas discharges for display; a wall charge accumulating dielectric that covers the first and second electrodes; and a protective layer provided 15 on the wall charge accumulating dielectric, wherein the protective layer is a sintered body including particles, a portion of which have a large particle diameter, and another portion of which have a small particle diameter, and a binder for binding the particles.

[0010]

20 A protective film formation method for a gas discharge display panel of the present invention, for forming a protective film on a wall charge accumulating dielectric that covers an electrode of an AC-type gas discharge display panel, includes the steps of: providing a paste including particles, a portion 25 of which have a large particle diameter, and another portion of which have a small diameter, and a liquid-phase precursor that forms a solid-phase binder when baked; and forming the protective

layer by laminating the paste on the wall charge accumulating dielectric, and baking the paste.

[0011]

[EFFECTS]

5 According to the gas discharge display panel of the present invention, the protective film is a sintered body including particles having a large particle diameter and particles having a small particle diameter, thereby increasing the distribution density of particles in the protective film. Accordingly, even
10 10 if it is difficult to increase the crystal grain density of the binder embedded between these particles, increasing the distribution density of the particles enables an increase in the crystal grain distribution over an entirety of the protective film.

15 [0012]

Also, according to the protective film formation method of this gas discharge display panel, the precursor is in the liquid phase, thereby substantially evenly distributing the particles by mixing the precursor and the particles, without the particles
20 aggregating in the protective film formation paste. Accordingly, baking this paste enables the formation of a protective layer in which the particles are evenly distributed throughout an entirety of the protective layer. Moreover, the distribution density of particles in the protective layer can be increased
25 since the paste includes particles with both large and small particle diameters. Accordingly, it is possible to increase the crystal grain density across the entirety of the protective film

even if it is difficult to increase the crystal grain density of the solid binder formed by baking the precursor.

[0013]

[WORKING EXAMPLE]

5 Next is a description of a working example of the present invention with reference to the drawings. Note that the drawings are no more than schematic representations for understanding of the present invention, and therefore the present invention should not be limited to the exemplary representations.

10 [0014]

Fig.1 is a perspective view that schematically shows a relevant structure of a working example of a gas discharge display panel, and in Fig.1, the two substrates are shown with their electrode formation faces facing each other, but without being 15 adhered together. Also, Fig.2 is a cross-sectional enlarged view schematically showing the relevant structure of the working example.

[0015]

As shown in Fig.1, the gas discharge display panel of 20 this working example includes a first electrode 10 and a second electrode 12 for forming gas discharges for a display, a wall charge accumulating dielectric 14 that covers the first and second electrodes 10 and 12, and a protective film 16 provided on the dielectric 14. As shown in Fig.2, the protective film 16 is a 25 sintered body that includes particles 16a with a large particle diameter, particles 16b with a small particle diameter, and a binder 16c for binding together the particles 16a and 16b.

[0016]

In this working example, the present invention is an AC-type surface discharge type gas discharge display panel wherein the first and second electrodes 10 and 12 are disposed parallel and provided on a substrate 18 such as a back plate, and the first and second electrodes 10 and 12 are extended in a first direction P. The first and second electrodes 10 and 12 are disposed adjacent to each other to form an electrode pair T, and a plurality of the electrode pairs T are provided in parallel. The wall charge, 10 accumulating dielectric 14 and the protective film 16 are sequentially provided on these electrode pairs T. The first and second electrodes 10 and 12 are, for example, stripe configuration electrodes.

[0017]

15 Furthermore, a third electrode 20 and barrier ribs 22 are provided on another substrate 24 such as a front plate. The third electrode 20 is extended in a second direction Q that intersects the first direction P in a planar view and that, here, is orthogonal to the first direction P. A plurality of the third 20 electrodes 20 are disposed parallel, and the barrier ribs 22 are disposed between adjacent third electrodes 20. The third electrodes 20 are, for example, stripe configuration electrodes, and the barrier ribs 22 are, for example, strip configuration ribs. Moreover, a separate phosphor 26 is provided on each of 25 the third electrodes 20. Three types of phosphors 26, red, green and blue, are disposed in a predetermined dispositional relationship.

[0018]

As shown in Fig.1, the electrode formation faces of the substrate 18 and the other substrate 24 are faced together, and periphery portions of the substrates 18 and 24 are sealed using 5 a sealing material that is not depicted. A discharge gas is enclosed in a discharge space between the sealed substrates 18 and 22.

[0019]

The first and second electrodes 10 and 12 are sustain 10 electrodes. An alternating current is provided to the discharge gas via the first and second electrodes 10 and 12 to generate or maintain plasma discharges for display emission. Upon applying an electrical potential difference between a pair of electrodes 10 and 12, a wall charge occurs on the protective film 16 due 15 to an effect of the wall charge accumulating dielectric 14, and this wall charge becomes an alternating current that flows through the discharge gas. Ultraviolet radiation generated by the plasma discharges excites the phosphors 26, causing them to emit light. The third electrodes 20 are address electrodes which are used 20 to selectively form plasma discharges for display emission in each of pixels. The barrier ribs 22 separate the discharge space for each pixel to prevent erroneous discharges.

[0020]

The protective film 16 is for preventing sputtering of 25 the wall charge accumulating dielectric 14. Here, the particles 16 and 16b of the protective film are MgO particles. This is because MgO not only has excellent sputter-resistant properties, but can

also reduce the discharge initializing voltage, and MgO is currently considered to be most suitable. Although the constituent elements of the particles 16a and 16b and the binder 16c may be different as long as a sputter-resistant protective film 5 16 can be formed, in the present invention, the constituent element of the binder 16c is of the same type as the constituent element of the particles, whereby the binder 16c is formed from an MgO binder. Note that the constituent elements of the particles 16a and 16b and the binder 16c may be something other than MgO.

10 [0021]

The MgO precursor that forms the MgO binder 16c when baked may be a precursor including, for example, magnesium di-ethoxide, naphthenic-acid magnesium, octylic acid magnesium, magnesium di-methoxide, magnesium di-n-propoxide, magnesium di-i-propoxide, or magnesium di-n-butoxide. There are other commercially available MgO precursors as well. When current MgO precursors are baked at a temperature of 580°C or below, it is difficult to form an MgO binder 16c that has a high crystal grain density. However, it is desirable for the baking temperature to 15 be 580°C or below in consideration of degradation etc. that may occur to soda lime glass which is generally used as the substrates 20 18 and 24.

[0022]

In contrast, the protective layer 16 includes particles 25 16a with large particle diameters, and particles 16b with small particle diameters, thereby enabling an increase in the distribution density thereof in the protective film 16 (e.g.,

see pp.338 to 340 of "Powder: Theory and Application" edited by Kiichiro Kubo et al., second ed., Maruzen KK). Accordingly, forming the particles 16a and 16b of the protective film 16 from particles with a high crystal grain density, and in particular 5 monocrystal grains, enables an increase in the crystal grain density of the protective film 16, even when it is difficult to increase the crystal grain density of the binder 16c.

[0023]

It is relatively simple to obtain monocrystal grain MgO 10 particles 16a and 16b. For example, independent monocrystal MgO particles can be formed by a vapor oxidization reaction between a magnesium (Mg) vapor and oxygen (O₂). This method is called a vapor phase method, according to which particles with a diameter in the range of 100 to 2,500 angstroms (hereinafter, represented 15 by Å) can be arbitrarily and optimally prepared. Although particles 16a and 16b with different diameters (e.g., 1000 Å for the MgO particles 16a, and 500 Å for the MgO particles 16b) are used here, the particles used in the protective film 16 may have three or more different sizes. If the particles have three or 20 more different sizes, out of two of the particles, one should have a large diameter and the other should have a small diameter.

[0024]

Figs.3A and 3B show steps for describing a working example of the protective film formation method for the gas discharge 25 display panel. In this working example, there is described an example of forming the protective film 16 included in the gas discharge display panel of Fig.1.

[0025]

First, the electrodes 10 and 12, which are for forming gas discharges for display emission, are formed on the substrate 18 of the AC-type gas discharge display panel, and thereafter, 5 the wall charge accumulating dielectric 14 is formed so as to cover the electrodes 10 and 12.

[0026]

In this working example, soda lime glass is provided as the substrate 18. A thick film paste (Ag-Pd alloy thick film paste) 10 including Ag-Pd alloy particles and a lead glass binder is laminated on the substrate 18, and thereafter, the paste is baked to form the electrodes 10 and 12. Lamination of the paste is performed by a lamination technique using, for example, a screen printing technique or a coater. Next, a glass thick film paste (Nippon 15 Electric Glass, AP5270) is laminated on the electrodes 10 and 12, and thereafter, the paste is baked to form the wall charge accumulating dielectric 14 (Fig. 3A).

[0027]

Next, there is provided a paste 30 including the 20 large-diameter particles 16A, the small-diameter particles 16b, and the liquid-phase precursor 28 which forms the solid-phase binder 16c when baked.

[0028]

In this working example, the particles 16a and 16b are 25 monocrystal MgO particles (Ube Industries, MgO particles with a purity of 99.98%) formed by a vapor-phase method. Also, the constituent element of the solid-phase binder 16c is the same

type as the constituent elements of the particles 16a and 16b. Accordingly, the paste 30 includes the liquid-phase precursor 28 that forms the MgO solid-phase binder 16c when baked. This liquid-phase precursor 28 may be a precursor that includes one 5 or more substances selected from magnesium di-ethoxide, naphthenic-acid magnesium, octylic acid magnesium, magnesium di-methoxide, magnesium di-n-propoxide, magnesium di-i-propoxide, and magnesium di-n-butoxide. The above-listed substances such as magnesium di-ethoxide may be used as is as 10 the liquid-phase precursor 28, or may be mixed with a solvent and used as the liquid-phase precursor 28.

[0029]

Here, the paste 30 is prepared by mixing 25 wt% of MgO powder as the particles 16a and 16b, 25 wt% of magnesium di-ethoxide 15 as the liquid-phase precursor 28, 5 wt% of ethyl cellulose as an organic resin, and 45 wt% of carbitol acetate as the solvent. Particles 16a with a diameter of 1,000 Å and particles 16b with a diameter of 500 Å are mixed in a ratio of 30 wt% to 70 wt%, and used as the MgO powder. Note that the organic resin and solvent 20 are used to adjust the viscosity of the paste 30.

[0030]

Next, the paste 30 is laminated on the wall charge accumulating dielectric 14, and baked to form the protective film 16.

25 [0031]

In this working example, the paste 30 is laminated using a lamination technique such as a screen printing method (Fig. 3B),

and thereafter, the paste 30 is baked to form the MgO protective film 16. A paste 30 in which the particles 16A and 16B are substantially evenly distributed without aggregating can be formed since the precursor 28 is in liquid phase. Accordingly, laminating 5 and baking this paste 30 enables the formation of a protective film 30 in which the particles 16a and 16b are substantially evenly distributed across an entirety of the protective film 30. Moreover, the distribution density of the particles 16a and 16b can be increased since the particles 16a have a large diameter and the 10 particles 16b have a small diameter. On the other hand, it is difficult to form the binder 16c with a sufficiently high crystal grain density if baking of the liquid-phase precursor 28 is performed at a temperature of, for example, 580°C or less such that the substrate 18 does not degrade. However, it is possible 15 to increase the crystal grain density of the protective film 16 since the distribution density of the particles 16a and 16b is high, and the particles are monocrystal grains.

[0032]

Next is a description of an experiment investigating panel 20 characteristics regarding an AC-type gas discharge display panel when the particles constituting the protective film 16 have the same diameter or two different diameters.

[0033]

Fig. 4 is a perspective view schematically showing a 25 relevant structure of the AC-type gas discharge display panel used in the experiment. In the experimental panel shown in Fig. 4, the substrate 24 was formed from soda lime glass, the barrier

ribs 22 were formed using a glass thick film paste (Dupont, 9741), and the green phosphors 26 were formed using a paste mixed from green phosphor particles (Kasei Optonics, P1-G1) and a screen oil. The phosphors 26 were only type green. The third electrode 5 20 was not provided. The cell pitch was 1 mm, forming 32×32 cells, and He-5%Xe gas was enclosed as the discharge gas at a pressure of 500 Torr. There were also provided experimental panels in which the protective film 16 had various thicknesses and the particles constituting the protective film 16 had varying diameters, the 10 panel characteristics of each of the experimental panels were examined. Other structure characteristics of these panels were the same as in the working example in Fig.1.

[0034]

Table 1, which is shown later, shows characteristics of 15 the particles constituting the protective films 16 of the experimental panels. The particles were formed from MgO particles (Ube Industries) formed by a vapor-phase method and having a purity of 99.98%, and the particle diameter in the product catalog is represented as particle diameter C. Particle diameter C includes 20 four types, 100, 500, 1,000 and 2,000 Å, and the table shows a BET value (m^2/g), a particle diameter (μm) calculated from the BET value, a particle diameter (μm) measured using an electron microscope, a bulk density (g/cm^3), and a tap density (g/cm^3) for each of the four types of MgO particles with particle diameters 25 C.

[0035]

As can be seen in Table 1, while there are fluctuations

in the particle sizes that were measured by the electron microscope, these measured particle sizes generally match the particle diameters C in the catalog. It can also be seen that compared to the bulk density of MgO, which is substantially 3.65 g/cm², 5 the bulk density and tap density of the particle sizes C are very small. Although the bulk densities and tap densities both increase as the particle sizes C increase, the rate of increase of the tap density is greater than the rate of increase of the bulk density. It can be seen that tap is effective as a method for increasing 10 the distribution density of the particles.

[0036]

An alternative method to tap in the formation of the protective film 16 involves the liquid-phase precursor 28. However, particles with a large particle diameter C absorb a small 15 amount of oil due to their small specific surface area (see BET value), and as a result, cracks readily form in the protective film 16 due to shrinkage during baking. Cracks shorten the life of the panel to a large degree, and it is therefore necessary to reduce the amount of the precursor 28 mixed in the paste 30, 20 in order to prevent the formation of cracks when the particle diameter C is large. However, reducing the amount of precursor 28 mixed in the paste 30 causes there to be areas lacking the binder 16c, thereby making it impossible to bind the particles. Upon experimentation, the inventors of the present invention 25 confirmed that it is better for the particle diameter C to be less than or equal to 2,000 to 2,500 Å in order to prevent the formation of cracks and areas lacking the binder 16c. Also, the

viscosity of the paste 30 is reduced if the particle diameter C is too small, thereby increasing flowage and making it difficult to laminate the paste 30. Upon experimentation, the inventors of the present invention confirmed that is better for the particle diameter C to be 500 Å or more in order to facilitate lamination of the paste 30.

[0037]

Table 2, which is shown later, shows characteristics pertaining to gas discharges of the experimental panels. In the 10 experiment, plasma discharges for display emission were created by applying a rectangular pulse with a frequency of 20 KHz to one electrode in a pair consisting of a first electrode 10 and a second electrode 12, while applying a rectangular pulse with a frequency of 20 KHz to the other electrode in the pair, where 15 the application timing of the latter pulse was shifted a half wavelength (25 μ s) from the application timing of the former pulse. Then the inventors examined the maximum discharge sustaining voltage V_{smax} (V), the cell current flowing in the electrodes 10 and 12 (cell current per 1 display cell) (μ A/cell), and the emission 20 efficiency (l_m/W) for each of the experimental panels. Table 2 shows these characteristics for each of the experimental panels, as well as the particle diameter of the particles constituting the protective films 16 and the thickness (μ m) of the protective 25 films 16. In experimental panels with the sample numbers 752, 755, 1100 and 1101, the particles constituting the protective films 16 have only one particle diameter each, which are shown in Table 2. In experimental panels with the sample numbers 1303,

1304, 1305 and 1306, the particles constituting the protective films 16 have two particle diameters (Å), E and F, and a mixture ratio e/f of the particles with diameters E and F are represented in Table 2 in the form of $E/F = e/f$. In Table 2, e and f show mixture amounts (wt%) of the particles with diameters E and F.

5 [0038]

As can be seen in Table 2, it is possible to further reduce the cell current and raise the emission efficiency by increasing the thickness of the protective film 16 when there is only one particle diameter, but the maximum discharge sustaining voltage V_{Smax} increases. In this case, it is necessary to set the film thickness of the protective film 16 to around 4 to 5 μm in order to limit the cell current to around 10 $\mu\text{A}/\text{cell}$, and an increase in the thickness of the film causes a concurrent high voltage of 288 to 312 V for the maximum discharge sustaining voltage.

15 [0039]

In contrast, if the particles have two different particle diameters, it is possible to reduce the cell current and raise the emission efficiency, even if the thickness of the protective film 16 is reduced. Moreover, the maximum discharge sustaining voltage V_{Smax} can be lowered to a minimum by reducing the thickness of the protective film 16. Given that the crystal grain density of the protective film 16 can be increased if particles with two different particle diameters are used, the cell current can be limited even if the thickness of the protective film 16 is reduced, and as a result, it is possible to lower the maximum discharge sustaining voltage V_{Smax} to a minimum. In this case, the cell current

can be limited to around 10 μ A/cell even if the protective film 16 has a film thickness of around 2.5 to 3.0 μ m, and furthermore, the reduction of the film thickness enables a concurrent reduction in the maximum discharge sustaining voltage V_{Smax} to around 249 5 to 254 V.

[0040]

Upon experimentation, the inventors of the present invention confirmed that, in order to increase the crystal grain density of the protective film 16 when using two different particle 10 diameters, it is preferable for there to be a two-fold or more difference between the particle diameters E and F, and when $e+f=100$ wt%, for e to be 25 to 75 wt%.

[0041]

Fig.5 is a perspective view schematically showing a 15 relevant structure of another working example of a gas discharge display panel. In this working example, the third electrode 20 and a multilayer wiring dielectric 32 are sequentially provided on the substrate 18. Also, the first and second electrodes 10 and 12 are provided on the multilayer wiring dielectric 32. Other 20 aspects of the structure are the same as in the aforementioned working example.

[0042]

In this case as well, a plurality of the third electrodes 20 are disposed parallel, and barrier ribs 22 are disposed between 25 adjoining third electrodes 20 in a planar view. Also, the phosphors 26 are disposed separately for each of the third electrodes 20 between adjoining barrier ribs 22.

[0043]

The present invention is not limited to the above-mentioned working examples, and accordingly, configurations of the constituent elements, arrangement positions, 5 formation materials, numerical conditions, etc. can be arbitrarily and favorably modified.

[0044]

For example, although the descriptions in the above working examples involved surface discharge-type gas discharge 10 display panels, there may be a simple X-Y matrix gas discharge display panel having a structure in which the third electrodes are not provided, the first electrodes are provided on one substrate, the second electrodes are provided on another substrate, and the first and second electrodes are arranged so as to intersect in 15 a planar view. In this case, the wall charge accumulating dielectric and the protective film are sequentially provided on the first electrodes on the one substrate, and the wall charge accumulating dielectric and the protective film are sequentially provided so as to cover the second electrodes on the other substrate.

[0045]

Table 1

Particle diameter C	100Å	500Å	1000Å	2000Å
BET value (m ² /g)	100~170	27~38	13~19	6~10
Particle diameter obtained from BET value (μm)	0.16~0.27	0.72~1.01	1.44~2.11	2.74~4.57
Particle diameter obtained from electron microscope (μm)	0.10~0.016	0.045~0.06	0.09~0.12	0.18~0.25
Bulk density (g/cm ²)	0.05~0.06	0.10~0.12	0.15~0.21	0.32~0.40
Tap density (g/cm ²)	0.06~0.07	0.14~0.17	0.23~0.31	0.53~0.70

[0046]

5

Table 2

Sample No.	Particle diameter	Thickness (μm)	V _{Smax} (V)	Cell current (μA/cell)	Emission efficiency (l _m /W)
752	500Å	4.4	312	12.2	0.622
755	1000Å	4.4	288	11.4	0.766
1100	2000Å	2.5	297	21.0	0.475
1101	2000Å	5.0	293	13.4	0.665
1303	1000Å /500Å =30/70	3.0	251	11.0	0.811
1304	1000Å /500Å =75/25	2.5	254	9.7	0.929
1305	2000Å /500Å =30/70	3.0	249	10.0	0.906
1306	2000Å /1000Å =30/70	2.8	253	12.3	0.810

[0047]

[EFFECTS OF THE INVENTION]

As is clear in the aforementioned descriptions, according

10 to the gas discharge display panel of the present invention, the protective film is a sintered body and therefore suited for mass production. Moreover, even if increasing the crystal grain

density of the binder that fills between the particles constituting the protective film is difficult, increasing the distribution density of the particles enables an increase in the crystal grain density over an entirety of the protective film. For this reason, 5 it is possible to form a protective film that can improve the panel characteristics of the gas discharge display panel.

[0048]

Also, according to the protective film formation method for the gas discharge display panel, particles for forming the 10 protective film can be distributed substantially evenly throughout the protective film formation paste, without aggregating, and baking this paste form a protective film in which the particles are distributed evenly throughout. Moreover, given that the distribution density of the particles in the protective film can 15 be increased, it is possible to increase the overall crystal grain density of the protective film even when it is difficult to increase the crystal grain density of the binder. For this reason, it is possible to form a protective film that can improve the panel characteristics of the gas discharge display panel.

20

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig.1 is a perspective view schematically showing a relevant structure of a working example of a gas discharge display panel.

25 Fig.2 is a perspective view schematically showing the relevant structure of the working example of the gas discharge display panel.

Figs.3A and 3B show steps for describing the working example of a protective film formation method for the gas discharge display panel.

Fig.4 is a perspective view schematically showing a relevant structure of a working example of a gas discharge display panel used in an experiment.

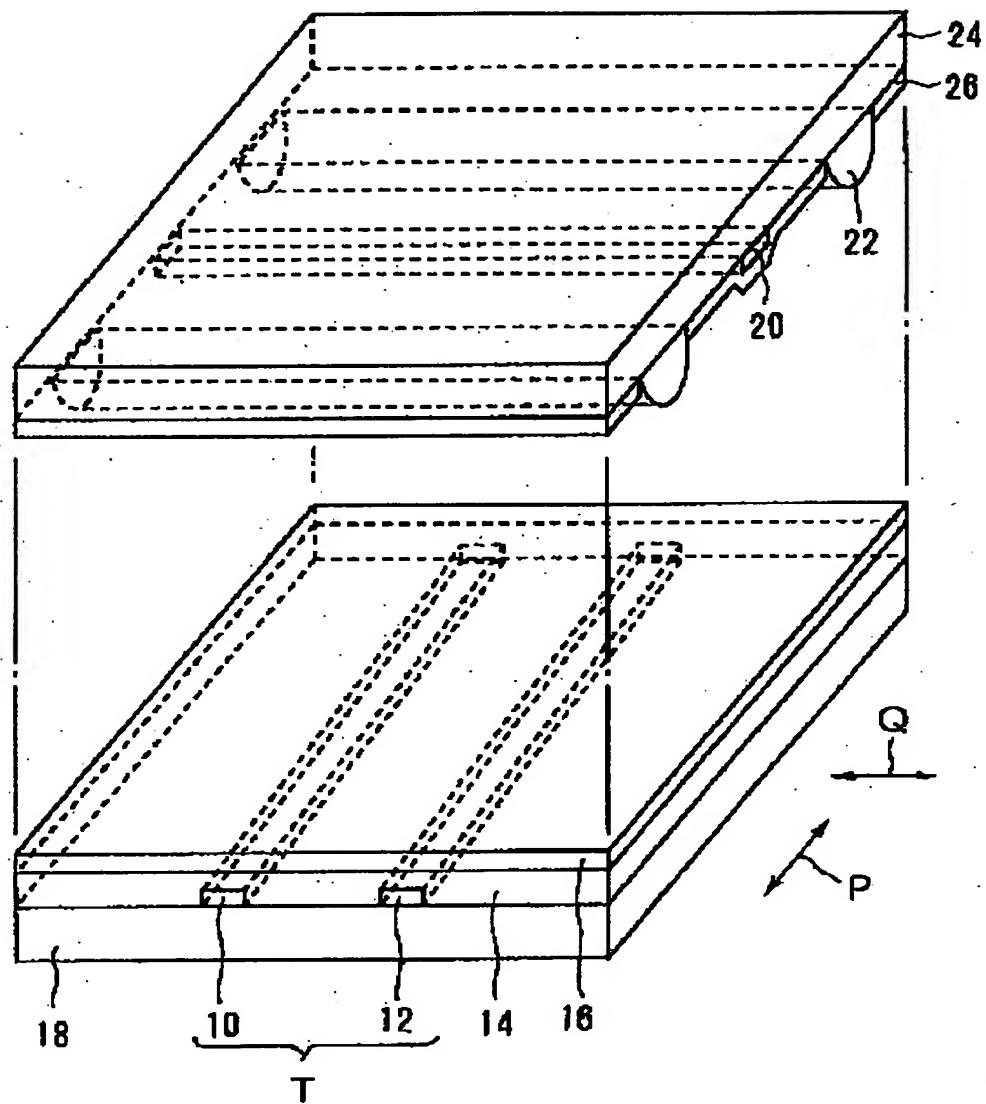
Fig.5 is a perspective view schematically showing a relevant structure of another working example of a gas discharge display panel.

10

[DESCRIPTION OF THE CHARACTERS]

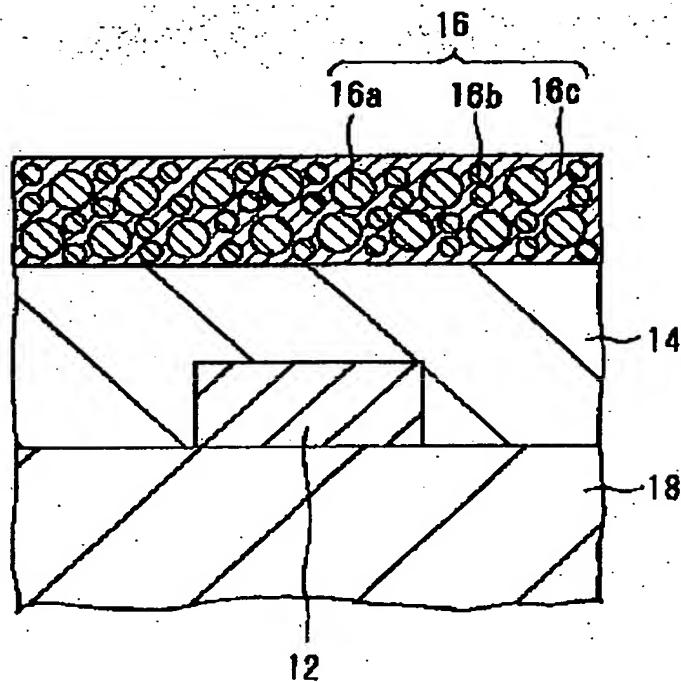
- 10 first electrode
- 12 second electrode
- 14 wall charge accumulating dielectric
- 15 16 protective film
- 16a large-diameter particle
- 16b small-diameter particle
- 16c binder
- 18,24 substrate
- 20 28 liquid-phase precursor
- 30 paste

FIG. 1



10 : FIRST ELECTRODE 12 : SECOND ELECTRODE 20 : THIRD ELECTRODE
14 : WALL CHARGE 16 : PROTECTIVE LAYER 18, 24 : SUBSTRATE
22 : BARRIER RIB 26 : PHOSPHOR

FIG. 2



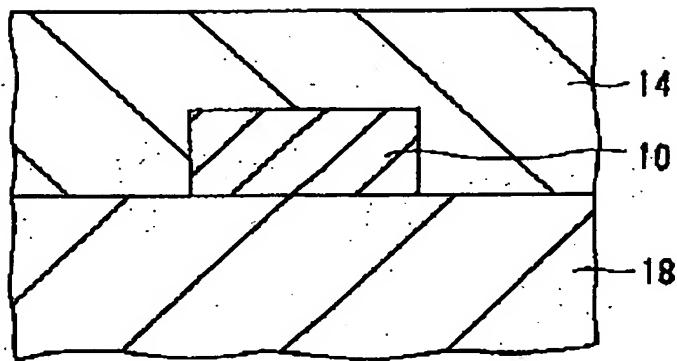
16a : LARGE-DIAMETER PARTICLE

16b : SMALL-DIAMETER PARTICLE

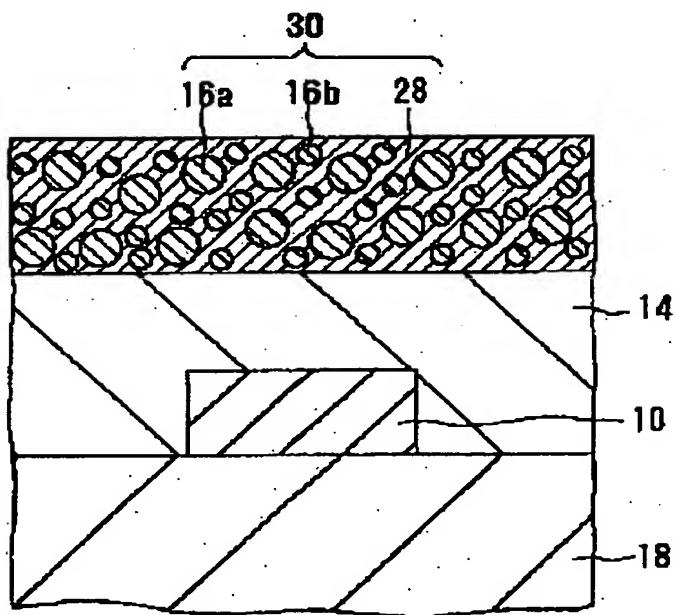
16c : BINDER

FIG. 3

(A)



(B)



28 : LIQUID-PHASE PRECURSOR
30 : PASTE

FIG. 4

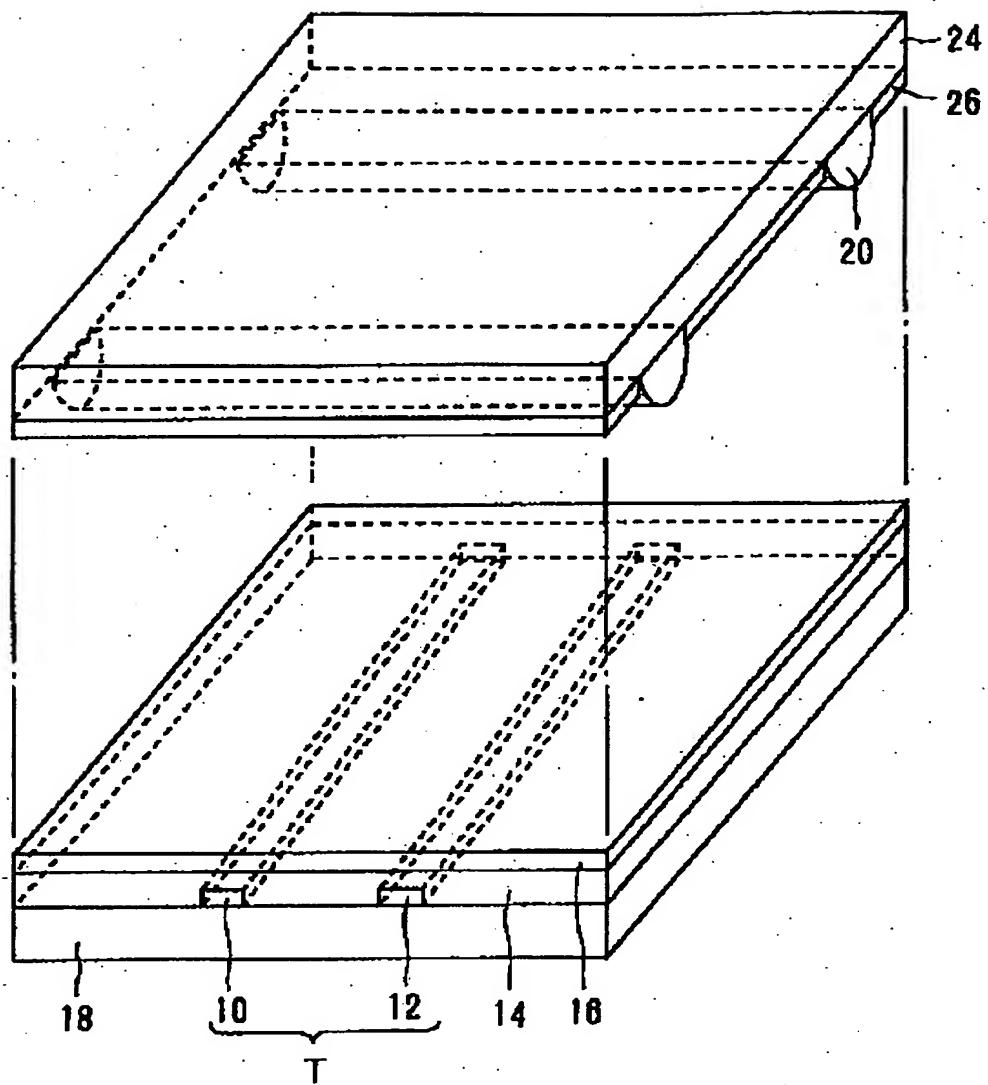
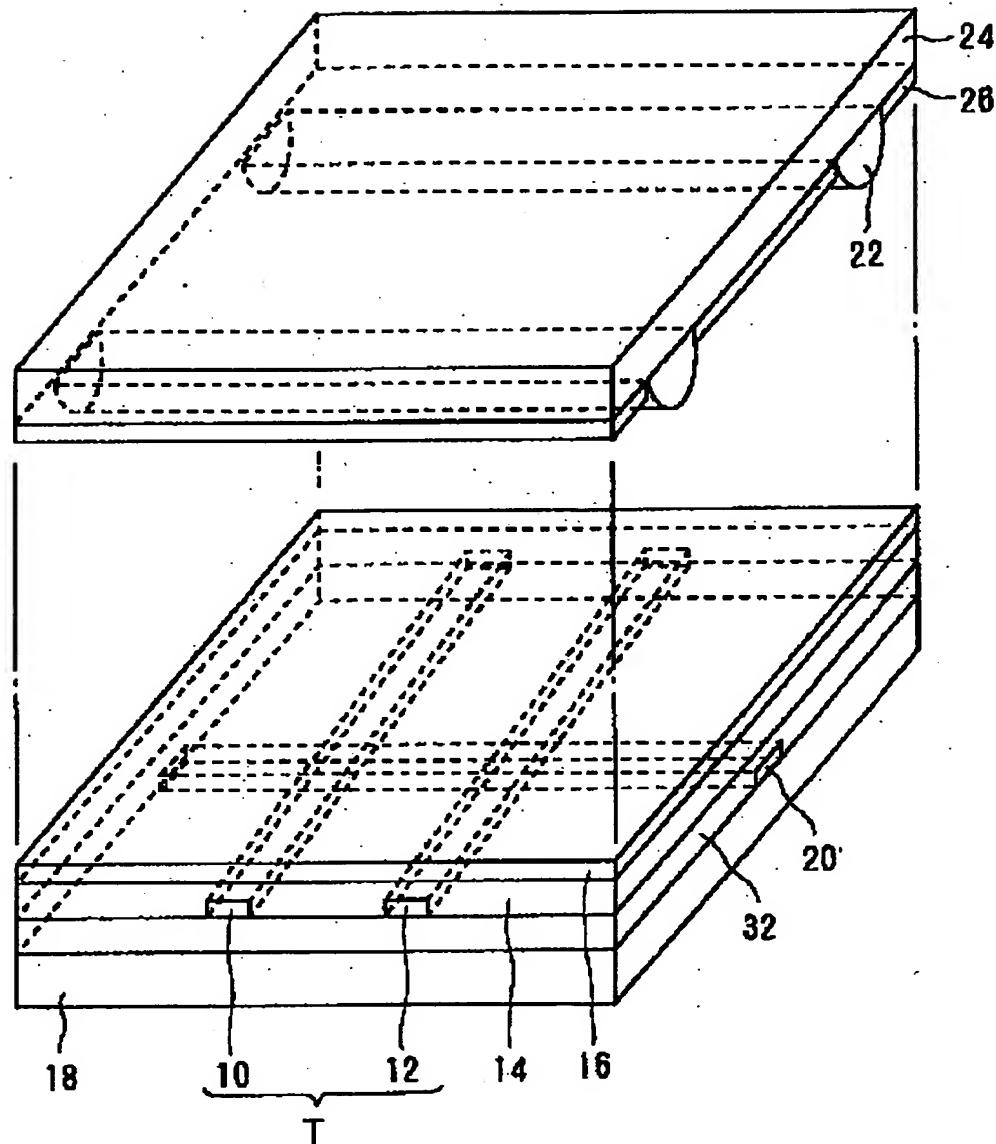


FIG. 5



32 : MULTILAYER WIRING DIELECTRIC